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Petroleum geology of the A-J graben, Orange Basin, South Africa

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The Orange Basin lies off the south western coast of Africa, offshore South Africa and Namibia. The basin formed during the rifting and separation of the South American and African plates, beginning in the late Jurassic and is defined by the extent of Cretaceous and younger sediments that occupy more than 150 000 km² to the 2000m bathymetric contour [1].

The basin fill comprises largely clastic material of Cretaceous age, transported into the basin by the westward flowing Orange, Berg and Oliphants Rivers and their related proto-river systems. A Hauterivian age unconformity (horizon R of Gerrard and Smith) separates the earlier rift geology of this divergent volcanic margin from that of the younger drift period. The post-rift section comprises a massive complex of delta sediments more than 8000 m thick in places. The development of the Orange Basin is described in more detail by numerous authors, for example Dingle [2], Gerrard and Smith [1], Jungslager [3], and authors mentioned therein.

The Orange Basin has all the typical features of a volcanic passive margin. The Cretaceous drift sediments are deposited on continental crust of the Namaqua and Cape segments of the African plate. A number of transverse marginal fracture zones with significant offsets occur within the ancient continental plate. A system of half graben within the continental plate extends roughly parallel to the coast. These grabens are generally faulted down to the west although some of the outer grabens are faulted down to the east. The medial hinge zone separates the inner isolated half-graben system from the main synrift basin. It is within one of these inner grabens, named the A-J graben, that a lacustrine petroleum system has been discovered.

The A-J half graben is one of the larger half grabens paralleling the west coast of South Africa and occurs in the central to southern part of the basin, about 25 km offshore. The graben is about 56 km long. There is a main trough of about 26 km in length and about 14 km wide, and at its deepest point, the graben contains about 4500 m of fill. In 1988, a stratigraphic well, A-J1, was drilled to a depth of 3728 m to investigate the succession in this graben. Prior to drilling, the low frequency reflections within the graben were thought to represent lavas, and prospectivity within the graben was expected to be low.

The well encountered interbedded Hauterivian age lacustrine sandstones and organic rich claystones below 3000 m, and at 3200 m oil was noted. Five cores were cut in succession and all sandstones were oil saturated. This was the first discovery of oil in the Orange Basin. Porosities of the sandstone were greater than 15% and permeabilities averaged 8.8 mD. No trap could be demonstrated and no oil or gas water contact was determined. However, the well was tested over a 10 m interval and a waxy, viscous oil of lacustrine origin was produced.

This paper examines the lithostratigraphy and depositional environment, source rock quality, source rock maturity, reservoir and hydrocarbons discovered within the graben.

References:

- [1] Gerrard I and Smith G C (1982) In: *Studies in Continental Margin Geology*: AAPG Memoir 34, 49-74
- [2] Dingle R V (1993) *Coms Geol Surv Namibia* 8:35-43
- [3] Jungslager E A (1999) In: *The Oil and Gas Habitats of the South Atlantic*: Spec pub Geol Soc 153, 153-168

